SIMULATION OF SLOPE STABILITY WITH *EUGENIA OLEINA* AGAINST SOIL EROSION

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I hereby declare that the work in this thesis is based on my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at Universiti Malaysia Pahang or any other institutions.

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ABSTRAK

Teknik kejuruteraan-bio telah diguna diseluruh dunia sebagai suatu kaedah untuk mengawal kestabilan cerun bergantung kepada kedalaman cerun itu sendiri. Kaedah yang paling biasa digunakan adalah dengan penggunaan “live pole” pada bahagian cerun bagi mengelakkan kejadian hakisan tanah yang akan memberi masalah dalam bidang kejuruteraan geoteknikal. Hakisan tanah juga mungkin terhasil daripada fenomena hujan lebat dan juga tekanan matrik tanah. Kajian ini dijalankan bagi mengenalpasti faktor yang mempengaruhi hakisan tanah yang berlaku pada cerun berdekatan makmal FKASA di Universiti Malaysia Pahang dan menentukan tujuan penanaman pokok dikawasan cerun samada membantu mengelakkan hakisan tanah daripada berlaku. Bagi mengenal pasti potensi akar pokok tersebut untuk menahan tanah daripada terhakis, beberapa ujian makmal telah dijalankan oleh para pelajar terhadap akar pokok yang telah ditanam dikawasan cerun, bagi mengetahui kekuatan akar pokok tersebut. Hasil ujian makmal akan digunakan bagi menghasilkan simulasi kestabilan cerun dengan menggunakan perisian yang digunakan secara meluas di dalam bidang kejuruteraan geoteknikal. Perisian yang akan digunakan di dalam kajian ini dikenali sebagai Plaxis 2D, sebuah perisian geoteknikal yang digunakan secara menyeluruh di dalam industri. Hasil keputusan yang diharapkan melalui simulasi ini adalah untuk mencadangkan rujukan dari segi pengukuhan untuk panduan masa hadapan bagi mengurangkan masalah kestabilan cerun.

ABSTRACT

Soil bioengineering techniques has been used worldwide as to control the slope stability. A commonly used idea is to apply live pole at the slope area in order to prevent the soil erosion which causing the problem in geotechnical engineering. Soil erosion may occur due to heavy rainfall or also from soil matrix pressure. This research is conducted with aim to find out the cause of soil erosion that occured at the slope near FKASA surveying lab in University Malaysia Pahang and the purpose of having *Eugenia Oleina* species planted on the slope whether it is helpful in preventing soil erosion. In this research, the results from the previous lab test was used in simulating the slope stability with *Eugenia Oleina* using the finite element software that is widely used in geotechnical engineering, which is known as Plaxis 2D. The factor of safety obtained from the simulation shows that the rooted soil with *Eugenia Oleina* are low compared to the unrooted soil.

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LIST OF SYMBOLS

β	slope angle (^{o})
c’	soil cohesion (kPa)
Δs	root cohesion (kPa)
$\emptyset'$	soil friction angle (^{o})
γ_{sat}	saturated bulk unit weight (kN/m^3)
γ_w	Unit weight of water (kN/m^3)
γ'	“submerged’’ bulk unit weight
z	vertical depth of the failure plane (m)
W_v	Overload due to vegetation (kPa)

LIST OF ABBREVIATIONS

FOS	Factor of Safety
KSU	Kompleks Sukan Universiti
FEM	Finite Element Method
FEA	Finite Element Analysis
SCD	Sand, Clay, Deep Clay
CSD	Clay, Sandy layer, Deep Sandy layer

CHAPTER 1

INTRODUCTION

1.1 Introduction

Slope stability problems always occur regardless of its location whether it happens in Malaysia or even worldwide. Slope is stable only when there is no movement happen or when it is stable to resist any soil movement at the slope. Slope also can be categorized into natural ground slope and man-made slope which exist along some highways and roads. Instability of slope often caused by the soil erosion that occurs after some heavy rainfall and also seepage pressure, despite of the gravitational forces which attracts the soils to fall down the slope.

The instability of slope may be reduced by using soil bioengineering techniques which has already been introduced in many countries in the world as a practical alternative using vegetation or live pole. It is stated that the vegetation technique is a combination of mechanical and hydrological effect to the slope (Ali N. et al, 2012). Shallow landslides with less than 2m deep are usually triggered by heavy rainfall and generally involve a thin layer of soil only but sometimes can affect large area.

Vegetation has both a silent effect on soil improvement to predict the landslide and a mechanical role to increase shear and pulling-out stress on the soil (Khalilnejad A et al, 2011). There are many researches has been done in centuries to prove that vegetation on the slope can prevent soil erosion to occur (Ali N. et al, 2012). It is stated that the roots from vegetation or live pole can give reinforcement and increase the shear strength of the slope itself. Hence, throughout this study, the focus will be on proving the roles of the live pole's roots in reducing the soil erosion at the slope in the research area.

The objective of this study is to measure the potential of the plant's roots in controlling the slope stability and the suction mechanism induce by the roots. The influence of the live pole will be derived and computed into Plaxis 2D (Jacob A. et al,

2018) to simulate the slope stability analysis. Another software which is Adonis also will be used in order to compare the results obtained from Plaxis 2D.

1.2 Problem Statement

Slope stability is an important aspect to make sure not only the safety of the area but also the civilians around the vicinity. Nevertheless, slope failure or soil erosion still can occur even though the design has already focused on the safety factor. It may occur to a shallow slope or even steep slope, no matter how the condition or the angle of the slope itself. In Malaysia, slope failure or soil erosion often happens even though Malaysia does not have a very steep slope, where the terrain of the mountains and hills is less than 25% (Hazlina and Jabil, 2017). Hence, a thorough study need to be establish in order to reduce the case of soil erosion where the slope design need to be observed.

Generally uncontrolled soil erosion may lead to slope failure. There are many factors that contribute to soil erosion and some of them already been mentioned in the introduction part. However, what is the main concern is if there are more to it especially with the live pole technique. Live pole is the bioengineering way of stabilizing and reinforcing slope from failure. Even though literature review shows the effectiveness of this method to anchorage slope and the soil, there is a subtle gap in this practice in Malaysia. There is no proper guideline or a well-documented research conducted using the local species or plants that works well for this purpose. Studies conducted in the past using live pole technique were only limited to check the stability of the slope and rather include the contribution of these plants in slope soil erosion. There should be a standard or a manual that suggests the type of species or plants that is suitable not only as to stabilize the slope but also to mitigate soil erosion at the same time. The choice of plants or species as live pole depends on the vulnerability of the slope soil to erosion.

1.3 Aim and Objectives

Aim

The main purpose of this research is to identify the cause of soil erosion which occurred at the shallow slope which is located near the surveying lab in University Malaysia Pahang.

Specific Objectives

1. To measure the potential of the plant roots in improving the soil properties.

2. To simulate the slope stability by using live pole.

1.4 Scope of Research

The focus for this research will be limited to the shallow slope which is available near the FKASA surveying lab and outside of KSU in University Malaysia Pahang, Gambang campus. The slope has been planted with a few of Eugenia Oleina's species, as a live pole, in order to study the role of its roots for reinforcement tools to prevent the soil erosion at the slope during rainfall. The research will be done by measuring the potential of the roots by using the data obtain from lab test.

The research will also focus on simulating the slope stability using the live pole with a 2D software which is Plaxis in comparison with another software called Adonis software. It will be taken about 3 months to complete this research on determining the cause of soil erosion and then simulate the stability of the slope by computing the data obtain from the previous investigation and lab tests. This research is also conducted to analyze the current shallow slope condition and previous investigations to propose a method in order to stabilize slope from future erosion.

1.5 Significance of Research

Slope instability is an inconvenient problem happens worldwide which occur without any warning. Some of the slope instability problems causing death and also infrastructural damage. Hence, by conducting this research, a guideline of how to retain the slope can be introduce for future references. This research is focusing on the importance of Eugenia Oleina species in inducing the slope stability. Thus, a guideline on species of live pole which is more suitable for slope stability also can be proposed in comparison to the current species used.

In addition, this research of simulating the slope stability using live pole also may contribute to a green technology, which adding to a very environmental-friendly and cost effective way in dealing with engineering design involving slope study. It is also can reduce the carbon print in comparison of using a traditional way of study apart from creating awareness on how technology can be useful to predict and prevent the problems arise.

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